perceived as separate impulses is the same; so, too, with the number at which beats and primary impulses pass into a tone. Intermittences of a tone, as well as beats and primary impulses, may pass into a tone, and the periodic maxima of vibration of a tone, when in sufficient number. The beat tone formed by two primary tones must be always weaker than these, though separate beats are stronger than the tones forming them.—In M. Grotrian's researches on the constants of friction of some salt solutions, and their relations to galvanic conductivity, the method for ascertaining the constants was that of observing the oscillations of a suspended disc with attached magnet (under the influence of a neighbouring magnet) in air and in the liquid examined. The observed generally similar course of temperature coefficients for fluidity and galvanic conductivity, with change of concentration, leads the author to conclude that the overcoming of internal friction forms an essential part of the work done by a current in passage through an electrolyte. In the case of chloride of potassium, it is found that the increase of conductivity is almost exactly proportional to the per-centage proportion (in the liquid); and M. Grotrian infers that the chemical changes he conceives generally to occur in chemical constitution of electrolytic molecules, on altering the concentration, do not occur here, but that with varied concentration, at the same temperature, the conductivity is only conditioned by the proportion of salt and the viscosity. With the numbers obtained in the experiments, it is possible to estimate for variously concentrated solutions of a salt, the temperatures for which the constants of friction have some determinate constant value; then to calculate the numbers for the conductivity at this temperature, and inquire according to what law these alter with the concentration. He thus shows that in the case of $NaCl$, $KaCl$, $CaCl_2$, and $BaCl_2$, the concentration and the viscosity are the principal factors which determine the amount of the conductivity.—In the next paper M. Wiedemann makes some adverse criticism on the recent researches of some French physicists in the domain of magnetism.—M. Holtz shows that wire-net is very well suited for proving that in the interior of conducting surfaces there is no electrostatic action. In one experiment, a bell-shaped cover, made of the net, is brought down by an insulating handle on an insulated metallic disc connected with an electric machine, and on which stands a pith-ball electrometer. The two balls do not diverge in the least on working the machine; but if the bell be removed, they do so at once. He shows further, how such a bell is like a filter or sieve, holding back the electricity while it affords partial passage to gaseous matter or dust. If a metallic point connected to earth be brought near the electrified bell, the balls are moved, but do not diverge, &c.—Dr. Wichmann studies the properties of doubly-refracting garnets; and we note a paper by Dr. Sohncke on the figures eaten out by dissolving liquids on blocks of rock salt, and Exner's method for producing solution-figures.—There is an account of an interesting inquiry, lately conducted by Dr. W. Siemens, on the velocity of propagation of electricity in suspended wires.

Proceedings of the Geological and Polytechnic Society of the West Riding of Yorkshire. New Series. Part 2. Pp. 57 to 112.—This part contains several very interesting papers on various points of local geology. Some of the papers will be of use to a wide circle of readers, such as Mr. C. Bird's on the red beds at the base of the carboniferous limestone in the north-west of England, and Prof. Green's on the variations in thickness of the Silkstone and Barnsley coal seams in the southern part of the Yorkshire coalfield, and the probable manner in which these and similar changes have been produced. Mr. Bird considers it better to regard the red beds in question as basement beds of the carboniferous limestone than to attempt to draw any arbitrary line in a series whose members appear so closely linked together. Mr. Tiddeman's concise account of the work and problems of the settle Victoria cave exploration will also be welcome. Five good plates accompany this number of the *Proceedings.*

Bulletin de l'Academie Royale des Sciences, 2 ser. tome 40, No. 12.—M. van Beneden contributes a long paper divided into six chapters on the early stages of the embryological development of mammals. In 1874 M. Beneden published his paper, in which he showed that in Hydractinia spermatozoids are derived from the ectoderm and ova from the endoderm. He suggested that the same law probably applied to vertebrata. Observations supporting his view with regard to Cœlenterata have been made by Koch and Fol, and M. Beneden has made embryological studies on the rabbit. A monograph with plates is promised. This paper is a *résumé.*—On the skeleton of a fossil whale in the museum at Milan, by P. J. van Beneden. Following up the descriptions of Pachyacanthus and Aulocetus already given, M. Beneden proceeds to describe the fossil found in 1806 at Mount Pulgnasco, preserved in the Milan Museum, figured by Cortesi and described by Cuvier. The description is accompanied by a plate, and there are references to fossil whales in the museums at Turin, Florence, Bologna, Parma, and Pisa.—On the period of cold of the month of December, 1875, by M. E. Quetelet.—On the Devonian sandstones of Condroz, in the Basin of Theux, in the basin between Aix-la-Chapelle and Ath, and in the Boulonnais. The paper is illustrated with a folding plate giving nine coloured sections, and its scope is to show that the beds of the different localities mentioned have the same relative stratigraphical relations as at Condroz. All of the subdivisions show a remarkable constancy in their petrological and palæontologica aspects.—On the description of some new birds, by M. Alph. Dubois. They belong to Cyanscitta and Icterus.—The theory of carnivorous and sensitive plants, by E. Morren. The article is a *résumé* of observations that have been made, and is well furnished with foot-notes. The index accompanies this number.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, May 18.—"Observations on Stratified Discharges by means of a Revolving Mirror, by William Spottiswoode, M.A., Treas. R.S.

In a paper published in Poggendorff's *Annalen*, Jubelband, p. 32, A. Wüllner has described a series of observations made, by means of a revolving mirror, upon the discharge of a large induction-coil through tubes containing ordinary atmospheric air at various degrees of pressure.

Wüllner's observations appear to have been directed rather to the nature of the coil discharge than to that of the stratifications.

For some time prior to the publication of the volume in question I had been engaged upon a series of experiments very similar in their general disposition, but with a somewhat different object in view, viz., the character and behaviour of the striæ; and of these, together with some recent additions, I now propose to offer a short account to the Society.

My general instrumental arrangements appear to have been similar to those of Wüllner; in fact, they could hardly have been very different. The tubes were attached to the coil in the usual way, and a contact-breaker of the ordinary form with its own electro-magnet was in the first instance used. For this and some other intermediate forms there was finally substituted a mercurial break (successfully arranged by my assistant, Mr. Ward), the plunger of which works on a cam attached to the axle of the mirror, so that the action of the contact-breaker is regulated by that of the mirror, instead of the reverse as in the former arrangement. With the broader tubes a slit was used; with the narrower this adjunct was less necessary; while with capillary tubes, such as are used for spectrum-analysis, it could be dispensed with altogether.

Striæ, as observed by the eye, have been divided into two classes, viz., the flake-like, and the flocculent or cloudy. Of the former, those produced in hydrogen tubes may be taken as a type; of the latter, those produced in carbonic tubes. But upon examining some tubes especially selected for the purpose, it was found that, while to this apparent a real difference corresponds, a fundamental feature of the striæ, underlying both, was brought out.

The feature in question was this: that the striæ, at whatever points produced, always have during the period of their existence a motion along the tube in a direction from the negative towards the positive terminal. This motion, which I have called for convenience the proper motion of the striæ, is for given circumstances of tube and current generally uniform; and its variations in velocity are at all times confined within very narrow limits. The proper motion in this sense appertains, strictly speaking, to the flake-like striæ only. The apparent proper motion of the flocculent striæ is, on the contrary, variable not only in velocity, but also in direction; and on further examination it turns out that the flocculent striæ are themselves compounded of the flake-like, which latter I have on that account called elementary striæ.

Elementary striæ are in general produced at regular intervals along the tube. The series extends from the positive terminal in the direction of the negative to a distance depending upon the actual circumstances of the tube and current. The length of the column, and consequently the number of the striæ, depends mainly upon the resistance of the tube, the duration of the entire current, and to a certain extent upon the amount of the battery surface exposed, and in that sense upon the strength of the current. The velocity of the proper motion, other circumstances being the same, depends upon the number of cells employed.

The paper next gave descriptions of the phenomena exhibited by several tubes; and drawings illustrative of the descriptions were added.

The following are some of the general conclusions to which the experiments detailed in the paper seem to lead:—

1. The thin flake-like striæ, when sharp and distinct in their appearance, either are short-lived or have very slow proper motion, or both.

2. The apparent irregularity in the distribution of such striæ during even a single discharge of the coil, is due, not to any actual irregularity in their arrangement, but to their unequal duration, and to the various periods at which they are renewed. The striæ are, in fact, arranged at regular intervals throughout the entire column. The fluttering appearance usually noticeable is occasioned by slight variations in position of the elementary striæ at successive discharges of the coil. With a view to divesting the coil discharge of this irregular character, as well as for other purposes, I devised two different forms of contact breakers (one of which is described in the Royal Society's *Proceedings*, 1874); but I postpone a description of the second, as well as of the experiments arising from its use, to another occasion.

3. The proper motion of the elementary striæ is that which appertains to them during a single discharge of the coil. This is always directed from the positive towards the negative terminal. Its velocity varies generally within very narrow limits. It is greater the greater the number of coils employed. In some tubes it may be seen to diminish towards the close of the discharge, and even in rare instances alternately to increase and to diminish during a single discharge.

4. Flocculent striæ, such as are usually seen in carbonic acid tubes, are a compound phenomenon. They are due to a succession of short-lived elementary striæ, which are regularly renewed. The positions at which they are renewed determine the apparent proper motion of the elementary striæ. If they are constantly renewed at the same positions in the tube, the flocculent striæ will appear to have no proper motion, and to remain steady. If they are renewed at positions nearer and nearer to the positive terminal, the proper motion will be the same as that of the elementary striæ; if they are renewed at positions further and further from the positive terminal, the proper motion will be reversed.

5. The velocity of proper motion varies, other circumstances being the same, with the diameter of the tube. This was notably exemplified in the conical tube. In tubes constructed for spectrum analysis the capillary part shows very slight, while the more open parts often show considerable proper motion.

6. Speaking generally, the discharge lasts longer in narrow than in wide tubes. In spectrum tubes the capillary part gives in the mirror an image extending far beyond that due to the wider parts.

7. The coil discharge appears, in the earlier part of its development at least, to be subject to great fluctuations in extent. In all cases there is a strong outburst at first. This, although sometimes appearing as a bright line, is always, I believe, really stratified. Immediately after this there follows a very rapid shortening of the column. The extent of this shortening varies with circumstances; but when, as is often the case, it reaches far down towards the positive terminal, a corresponding diminution of intensity is perceptible in the negative glow. The column of striæ, after rising again, is often subject to similar fluctuations. These, which are sometimes four or five in number, are successively of less and less extent, and reach only a short distance down the column or striæ. The rifts due to these fluctuations then disappear, and the striæ either continue without interruption, or follow broken at irregular intervals, until the close of the discharge.

8. The effect of the proper motion, taken by itself, is to shorten the column of striæ. But, as we have seen, the striæ are in many cases renewed from time to time. In regard to this point, the head of the column presents the most instructive features. After the cessation of these rifts, the general appearance of the field is that of a series of diagonal lines commencing at successive points which form the bounding limit of the column at successive instants of time. If the points are situated in a horizontal line, the striæ are renewed at regular intervals at the same place; and the length of the column is maintained by a periodic renewal of striæ, a new one appearing at the head of the column as soon as its predecessor has passed over one dark interval. If the boundary of the illuminated field rises, the length of the column increases; if it descends, the column shortens. In every case, however, the growth of the column takes place by regular and successive steps, and not irregularly. The intervals of the new striæ from one another and from the old ones are the same as those of the old ones from one another.

9. The principal influence of a change in the number of cells used appears to consist in altering the velocity of proper motion. A change in the amount of battery-surface exposed produces a corresponding change in the duration of the entire discharge, as well as apparently in the development of some of the minor details of the striæ.

10. When the proper motion of the elementary striæ exceeds a certain amount, the striæ appear to the eye to be blended into one solid column of light, and all trace of stratification is lost. When this is the case the mirror will often disentangle the individual striæ. But there are, as might well be expected, cases in which even the mirror is of no avail, but in which we may still suppose that stratification exists. A variety of experiments have led me to think that the separation of the discharge into two parts, viz., the column of light extending from the positive terminal, and the glow around the negative, with a dark space intervening, may be a test of stratified discharge; but I cannot affirm anything certainly on this point.

Chemical Society, May 18.—Prof. Abel, F.R.S., president, in the chair.—The first paper read was on the action of malt extract on starch, by Mr. C. O'Sullivan, showing that under these circumstances it is converted into a mixture of maltose and dextrin, the proportion of which varies with the temperature at which the reaction takes place.—A communication was then made by Dr. H. E. Armstrong and Mr. Gaskell on metaxenol, the metadimethylated phenol.—There were also papers on the gases enclosed in cannel coals and in jet, by Mr. J. W. Thomas, on phenomena accompanying the electrolysis of water with oxidisable electrodes, by Dr. J. H. Gladstone and Mr. A. Tribe, and on the estimation of hydrogen occluded by copper, with special reference to organic analysis, by Dr. J. L. W. Thudichum and Dr. H. W. Hake.

Meteorological Society, May 17.—Mr. H. S. Eaton, president, in the chair.—James Lloyd Ashbury, John Broun, John Brown, Edmund Cruise, James Eldridge, George Garnett, John Hopkinson, Robert Pickwell, William Ford Stanley, Rupert Swindells, Charles Tarrant, Thomas Taylor Smith, were elected fellows of the Society. The following papers were read:—Remarks on the present condition of maritime meteorology, by Robert H. Scott, F.R.S. This paper gives a history of all that has been done in maritime meteorology since the Brussels conference in 1853, up to the present time.—In the mean temperature of every day at the Royal Observatory, Greenwich, from 1814 to 1873, by James Glaisher, F.R.S. This paper, which is a continuation of former ones on the same subject, contains the observations for the ten years, 1864 to 1873, which being combined with the previous ones, give the mean for sixty years. On the meteorology of Mozufferpore, Tinhoot, for 1875, by C. H. Pearson.—New wind chart, by Lieut.-Col. G. E. Bulger.

Physical Society, May 13.—Prof. G. C. Foster, president, in the chair.—The following candidates were elected members of the Society:—Prof. T. Andrews, Rev. R. H. M. Bosanquet, M.A., and David Howard.—Mr. Thompson, B.A., B.Sc., concluded the communication on the supposed new force, which he commenced at the last meeting of the Society. In the arrangement which he has adopted for obtaining the spark, the secondary current of a Rhumkorff's coil is made to traverse a short coil of wire which is thoroughly insulated from the internal core, and into the circuit an arrangement is introduced by means of which the current may be made to traverse a variable thickness of air in its course round the short coil. It is found that if this spark is very short the spark obtained from the internal core is also short, but as we increase the thickness of air to be traversed, the spark which may be drawn off increases; the greatest effect, however, is produced when one terminal of the coil is connected with the earth, the spark then obtained being about half an inch in diameter. Mr. Edison considered that the spark was retro-active, but Mr. Thompson showed, by an experiment, that deficient insulation might lead to such a conclusion. He then proceeded to show that just as the charge given to a gold-leaf electroscope is at times positive and at times negative without any apparent reason for the change, so if the core of the arrangement employed be connected with a Thomson's galvanometer, the needle will be found to wander irregularly about the scale on both sides of the zero. In order to show that these experiments are identical with those conducted as originally described by the discoverer, the terminals of the induction coil were connected with the coil of an electro-magnet, the same means of including a layer of air in the circuit being introduced. The effect in this case was found to be precisely similar to that obtained with the special arrangement previously used; with a brush discharge a Geissler's tube could be illuminated, and, when the layer of air was infinitesimal, the spark produced was also infinitesimal. It was then shown that, if the spark at the point of contact in the key when a direct battery current traverses the coil be done away with by shunting the extra current which gives rise to it, no spark can be obtained from the core. It thus appears that no spark is obtained when there is no necessity for an inducing current to accumulate until it has sufficient tension to leap over a resisting medium, and that, as the thickness of this resisting medium increases, the spark obtained becomes greater. Evidently on these occasions the current has time to attract unlike and repel like electricity in the core, and if a conductor in connection with the earth be presented to this core, the like electricity will escape; hence a spark will result. As soon, however, as the tension has become sufficient to leap over the layer of air, it will be necessary to restore equilibrium in the core. Hence there will be a return spark in the opposite direction. From these experiments it will be seen that the phenomena observed may be explained by the ordinary laws of induction.

Institution of Civil Engineers, May 23.—Mr. Abernethy, vice-president, in the chair.—The paper read was on the permanent way of railways, by Mr. R. Price Williams.

CAMBRIDGE

Philosophical Society, May 8.—Mr. W. M. Hicks drew attention to some experiments of Messrs. Stewart and Tait on the heating of discs by rapid rotation in vacuo, and which they referred to the friction of the ether. It was shown that it was not necessary to have recourse to this explanation; that nearly all the effects could be accounted for if it is supposed that the disc, through the rapid rotation, has expanded and consequently been lowered in temperature; that whilst rotating it is raised to the temperature of the surrounding region; and therefore when the rotation is stopped, and the disc has shrunk to its former size, it will give out the heat it had taken in whilst rotating. In the case of silver it was shown that the disc ought to show a rise of ·4° C. if the rotation had been continued for some time, and this was compared with the rise of ·47° C. which Messrs Stewart and Tait had observed in an aluminium disc, thus showing that the effect was of the same order of magnitude in the two cases. It was also shown that if the whole heating were due to ethereal friction, that this friction would be ·0006 lbs. per square foot, and that if we suppose this amount to act on the surface of the earth, the day would be lengthened in the course of a century by something like ·006″.—Prof. Maxwell afterwards made a communication on the equilibrium of heterogeneous substances.

STOCKHOLM

Royal Academy of Sciences, Feb. 9.—Herr Gyldén communicated a transformation of the formula—

$$\left\{1 + 2l_1 \operatorname{Cos}\left[2\,am\,\frac{2K}{\pi} + \Lambda\right] + l_1^2\right\}^{-\frac{\pi}{2}}$$

which plays an important *rôle* in the method of deducing a general formula of perturbation for periodic comets worked out by him. This transformation is mainly grounded on the relation—

$$e^{\sqrt{-1}\,am\,\frac{2K}{\pi}} = e^{\sqrt{-1}\,x}\,\frac{\eta(-x)}{\eta(x)},$$

where

$$\eta(x) = \left(1 - qe^{2\sqrt{-1}x}\right)\left(1 - q^3e^{-2\sqrt{-1}x}\right)\left(1 - q^5e^{2\sqrt{-1}x}\right)$$

and upon certain algebraic relations between different η-functions. The final result is specially applicable when a comet comes to that part of its path which lies nearest the perturbing planets; in this case l becomes inconsiderably less than 1, and Λ may be taken to fall within exceedingly narrow limits in the neighbourhood of 0. The following papers were given in:—Myriopoda from Siberia and Waigat's Island, collected during Nordenskjöld's expedition, 1875, by Anton Stuxberg. Eighteen species are described, of which only one was previously known to exist in Siberia, and fifteen are new to science, viz.—Lithobius 10, Iulus 1, Polydesmus 2, and Craspedosoma 2. Of the twenty-seven Siberian species now known only two are European.—Determinations of geographical position during the Swedish expedition to Novaya Zemlya and the Kara Sea, 1875, calculated by E. Jäderin.—On monœcism in fishes, by A. W. Malm.—Prof. Borenius communicated magnetic observations made at Helsingfors simultaneously with those made by the Swedish expedition at Spitzbergen during the winter 1872–3.

BERLIN

German Chemical Society, May 8.—A. W. Hofmann, president, in the chair.—E. Schunck and H. Römer by fusing Anthraflavinic and isoanthraflavinic acids with potash, have obtained two isomeric purpurines $C_{14}H_8O_5$. Anthrapurpurine is identical with a substance formerly obtained by Mr. Perkins; flavopurpurine obtained from the second of the two substances is the fourth isomeric purpurine.—A. Boettinger in studying anew the decomposition of tartaric acid by heat, believes that the formation of pyruvic acid is preceded by that of glyceric acid.—Dr. T. Stenhouse and C. E. Groves in treating pure naphthaline with sulphuric acid, obtained not only β-naphthaline-sulphurous acid, but also two napthaline-sulphones $C_{20}H_{14}So_2$, easily separated by sulphuret of carbon. They yield by oxidation two isomeric naphthaline-sulphuric acids.—T. Annaheim described dibromonitrooxysulphobenzid $(C_6H_2BrNO_2OH)_2SO_2$ and the corresponding iodo-compound. The same chemist described a red colouring substance obtained by the action of fuming sulphuric acid on cresol.—W. Rimarenko described β-chloronaphthaline obtained from β-naphthol and from β-naphthaline-sulphuric acid with PCl_5,—the method formerly described by M. Clare.—E. v. Gorup Besancy and H. Will have investigated the liquid secretion of insectivorous plants (Nepenthes phyllaniphera). Albumine, fibrine, &c., are transformed into peptone. This digestion takes place in a very short time, when the secreting organ of nepenthes has been excited by contact,—the liquid having under these circumstances an acid reaction. The secretion of non-excited glands is rendered equally active by the addition of any acid, particularly of malic and citric acids.—H. Vogel published researches on the influence of different rays of light on bromide of silver.—F. Tiemann and N. Matsnold have prepared nitro-protocatechic acid and some of its derivatives, also nitro-vanillinic acid and acetyl-nitro-vanillinic acid.—F. Tiemann and C. Reimer have obtained paraoxybenzoic aldehyde by treating phenate of potassium with chloroform.—E. Hoffmann described derivatives of hesperidine, particularly an acid $C_{10}H_{10}O_4$, which with potash yield protocatechic acid.

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